

Development Test Results of a Wax Actuated Heat Switch for Mars Rover Application

by Michael Pauken*, Eric Sunada, Keith Novak, Charles Phillips, Gaj Birur at the Jet Propulsion Laboratory, California Institute of Technology, Pasadena CA

and Kurt Lankford** at Starsys Research Corp. Boulder CO.

*Primary Contact address:

Jet Propulsion Laboratory

M/S 157-316

4800 Oak Grove Blvd

Pasadena, CA 91109

Phone: (818) 354-4242

Fax: (818) 393-4206

E-mail: Michael.T.Pauken@jpl.nasa.gov

**Starsys Research

4909 Nautilus Ct. N.

Boulder, CO 80301

Phone: (303) 530-1925 x124

Fax: (303) 530-2401

E-mail: Kurt@Starsys.com

Abstract:

A wax actuated heat switch has been developed for thermal control of the batteries used on the 2003 Mars Exploration Rovers. Thermal model temperature predictions show that the rover batteries will exceed the maximum allowable flight temperature of 30C during the Mars afternoon early in the planned missions. The heat switch is used to reject heat from the warm battery inside the rover to a radiator exposed to the ambient environment outside the rover. The wax actuated switch was designed to close a gap between in a split aluminum cylinder when the warm side of the switch exceeds the wax melting point of 18C. When the battery is cooled below 18C the wax solidifies and the switch opens the space between the aluminum cylinders. This significantly increases the thermal resistance of the switch and protects the battery from freezing during the Mars night.

This paper describes the development test program designed, in part, to measure the thermal conductance of the heat switch in an 8 Torr CO₂ environment over the expected operating temperature range of the battery. When the switch is closed, it has a conductance of about 0.6 W/C at a warm side temperature of 25C. When the switch is open, it has a conductance of 0.019 W/C at a warm side temperature of 5C. The test program also included measuring the battery temperature profile over a hot case and a cold case Mars diurnal cycle. The test results confirm that the battery will remain well within the upper and lower allowable flight temperatures in both cases.